possible through an increase of rainfall, such increase must be of notable amount. The effect upon agriculture of a minute increase would be scarcely appreciable, and certainly would not suffice to produce the effects claimed for it, or to explain the wide-spread belief in this increase which is prevalent. In examining the rainfall records, we are, then, to look for substantial amounts of increase, — several inches annually. I would add that these records are now ample for testing this theory, and their testimony should be conclusive.

I find in this area twenty-six stations at which rainfall records have been kept for periods ranging from six to twenty-eight years, the total number of years of record being three hundred and ten. These stations are scattered widely over the area in question, from its eastern to its western border, and involve all stages of settlement. Now, if there has occurred an increase in the amount of rainfall, that of the later years of any series should, on the whole, be greater than that of the earlier years. I have therefore cut each of these series in the middle, and added up the rainfall of each half. These are presented in the following table, where the first column gives the names of the stations; the second, the number of years in the series; the third and fourth, the total rainfall in the first and second halves of each series respectively; and the fifth, the increase or decrease, the former being distinguished by the +, the latter by the — sign: —

Fort Leavenworth, Kan.	28	518	525	+ 7
Leavenworth, Kan.	18	366	362	− 4
Manhattan, Kan.	28	400	407	+ 7
Lawrence, Kan.	18	306	319	+ 13
Fort Larned, Kan.	12	131	119	− 12
Topeka, Kan.	8	117	140	+ 23
Dodge City, Kan.	12	105	149	+ 44
Wallace, Kan.	6	50	59	+ 9
Atchison, Kan.	8	189	156	− 33
Baxter Springs, Kan.	6	130	102	− 28
Burlingame, Kan.	6	84	96	+ 12
Council Grove, Kan.	8	178	141	− 37
Fort Hays, Kan.	6	55	79	+ 24
Fort Riley, Kan.	16	185	214	+ 29
Olathe, Kan.	8	201	194	− 7
Belleville, Kan.	14	184	218	+ 34
De Soto, Neb.	6	109	80	− 29
Fort McPherson, Neb.	6	58	52	− 6
North Platte, Neb.	12	108	120	+ 12
Omaha, Neb.	18	319	337	+ 18
Omaha Agency, Neb.	6	75	78	+ 3
Yankton, Dak.	12	170	178	+ 8
Bismarck, Dak.	12	140	102	− 38
Fort Benson, Mont.	6	34	40	+ 6
Cheyenne, Wyo.	16	84	98	+ 14
Denver, Col.	14	112	103	− 9

It will be seen at once that the individual results are contradictory in a high degree; those from sixteen stations showing an increase, while ten stations show a decrease. These contradictions, which are due to the irregularity of the rainfall may, however, be in a measure eliminated by combining the results, under the supposition that the change, if any, has been a progressive one. Under this assumption, the sum of the earlier halves of the different series should be less than that of the later halves. Adding them together, it is found that the aggregate rainfall at all the stations was, in the first half of the series, 4,408 inches, and in the second half, 4,468 inches; showing that there has apparently taken place an increase of 60 inches in the total amount of rainfall at all these stations in a total of 310 years, or, to put it in another form, there has fallen in each year of the second half of these series 0.4 of an inch more rain than in the first half. It is unnecessary to add that this is not the sort of increase for which we were searching, as an increase of but a fraction of an inch certainly could not produce the results which are claimed. An examination of the seasonal distribution of the rainfall shows that that also has undergone no material change since settlement began in this region. We may therefore dismiss as baseless the popular idea of an increase in rainfall, either annual or during the growing season, and look elsewhere for an explanation of the phenomena of settlement which the plains present.

The early explorers, of the time of Fremont and the Pacific Railroad surveys, based their judgments of the capabilities of the country for agriculture upon the character of the natural products, the absence of trees, the presence only of sparse, hardy grasses, the cactus, and the yucca. Their judgment was a mistaken one, as events have amply proved.

Since their time physical geographers have set arbitrary limits to safe farming without irrigation, basing their reasoning upon the known rainfall of the region, and that supposed to be required for the average farm product. Subsequent experience has shown that a much smaller quantity of rain is essential than was supposed. To my mind, there is little more to be said. If it be found, that, with an annual rainfall during the growing season not greater than ten inches, farming can be carried on successfully, the only question remaining is, how the mistake could have been made of supposing that it required a greater amount.

There is no doubt that cultivation adds greatly to the economy of the rainfall. The surface of the plains in an uncultivated condition is mainly bare, hard ground, but slightly protected by its covering of grasses. From such a surface the rain flows off freely, and an unusually large proportion of it finds its way into the streams, while a correspondingly small proportion sinks into the ground. The farmer, with plough and harrow, changes all this, and retains in the soil most of the rainfall. From year to year the supply in the soil increases, so that the subsoil becomes in time a reservoir from which the surface soil may draw in times of drought. Furthermore, the scanty vegetation offers little protection against evaporation, which is excessive upon the barren plains; but the ampler mantle which cultivation spreads over the soil prevents its moisture from disappearing in the atmosphere with so great rapidity.

How much farther westward into the arid region can the farmer push? This is a very important question, affecting the value of millions of acres of land; for, if this land can be cultivated only by the aid of irrigation, nine-tenths of eastern Montana, Wyoming, Colorado, and New Mexico, together with western Dakota, Nebraska, and Texas, must be given over to the cattle-men in perpetuity, as the streams are entirely insufficient for irrigation. A conclusive and satisfactory answer can be given only by the farmer

HENRY GANNETT.

WASHINGTON SCIENTIFIC NEWS.

A Novel Way of Forming Alloys. — The Constituents of Sugar. — Rainfall in the Arid Regions. — Irish Myths and Folk-Tales. — Examining Fats.

The Formation of Alloys.

THE following is an abstract of a note read before the Philosophical Society by William Hallock, of the United States Geological Survey, Feb. 18, 1888: —

In the *Berichte der chemischen Gesellschaft*, vol. xv. 1882, pp. 595–597, W. Spring describes the formation of alloys by submitting the filings of the constituent metals to high pressure, without appreciable rise in temperature. Wood's alloy of cadmium, tin, lead, and bismuth he produced by mixing proper weights of the filings of these metals, and subjecting them to a pressure of 7,000 atmospheres. The block thus obtained was again filed up, and subjected to the same pressure.

In this way a block of metal was produced which possessed the physical properties of ordinary Wood's alloy, formed by melting the mixed constituents.

W. Chandler Roberts repeated this experiment (*Chemical News*, vol. xlv. 1882, p. 231), and verified Mr. Spring's results.

In seeking an explanation of the above phenomenon satisfactory

to myself, I reasoned, that if at any time during the first compression, the subsequent filing, or the second compression, anywhere throughout the mass, the constituent metals were in contact, at that point there would be a minute globule of the alloy, — a molecule of alloy, as it were. If, now, the temperature of the block, either during compression or subsequently, be raised to 70° C., then that molecule of alloy will fuse, and act as a solvent upon the surrounding metals till the whole mass is fused.

If my idea was correct, I concluded that perhaps I could produce the result without pressure, giving more time and an appropriate temperature to the substance.

The filed metals in the proper proportions were mixed, and packed into the bottom of a 'sealed tube,' such as is used for blowpipe work, using no greater pressure than could be conveniently exerted with a piece of wire, one-eighth of an inch in diameter, held between the thumb and finger. This tube was hung in the water-bath of the laboratory over night (eighteen hours), thus maintaining it at a temperature of from 98° to 100° C. On examination, the filings had settled down considerably. The tube was then struck upon the table, jarring them down still more, and in an hour or two the whole was a molten globule. The experiment was repeated, using larger quantities packed in with a lead-pencil, and occasionally pressing the mass together with the pencil, producing twenty or thirty grains of alloy. Since then, tin and lead have been fused together at 200° C., tin melting only at 230° C.; also sodium and potassium at ordinary temperatures (20° C.), the first melting at about 90° C., and the latter at about 60° C. Thus I proposed the law, that *an alloy can be formed out of the constituents at a temperature above the melting-point of the alloy, although it be far below that of any constituent, with no (appreciable) pressure.* The extended verification of this law, as well as the electrical and thermal phenomena associated therewith, will be the subject of a work which I hope soon to undertake and carry through.

The Chemistry of Sugar.

The following is an abstract of some remarks made by Prof. H. W. Wiley, of the Agricultural Department, at the meeting of the Chemical Society, held Feb. 9. Referring to his recent work in Louisiana, he said, "When the cane is subjected to pressure analysis, it is found that the juice differs from that in the ordinary bagasse. There are two kinds of juice in the cane, — one stored in the cells, and the other in the circulation. The juice oozing from the end of the cane, at first, from compression, is like water, and has no sugar, so far as the taste goes." Another subject of investigation had to do with the determination of the total solids in the juices, which is a difficult problem. It was fully demonstrated that the saccharometers in use are not reliable, because they are mostly graduated to pure sugar solutions, while in the cane juices there is a mixture of various solutions. Professor Wiley described the process he used of drying to obtain the total solids, and his method of determining them by the addition of alcohol and the use of paper coils. He also said, in regard to the genesis of sucrose, that it had been proved beyond doubt that it is a direct formation, and not a secondary product. All the facts are against the old theory that starch is formed first, and the sugar from it. The sugar in the circulatory sap is never a starch sugar, and cannot have come from starch. It is found in the leaf, and is formed by the aid of chlorophyl. He also described the polarizing instrument, and said that many improvements have been made in it. Another point developed is that the amount of available sugar in the cane is greater than it has heretofore been supposed to be. In closing, he said that many of these points had been indicated in his previous work, but were emphasized by his recent investigations.

Rainfall beyond the Mississippi.

Gen. A. W. Greely, chief signal officer, gave to the Washington Philosophical Society, at its regular meeting, Feb. 18, the partial results of a study he is now engaged upon of the rainfall in the trans-Mississippi region. He had before him a number of maps upon which had been charted the observations which were the basis of his study, and referred to them constantly as he spoke. He said that the idea that there is any part of the West that is absolutely rainless is now a banished myth. During the past ten years the number of stations for observation has been doubled, so that there are, in twelve States and Territories, nearly one hundred stations; and the observations, if reduced to a single one, would cover a period of nearly five thousand years. The result of charting these observations has been to reduce very greatly the areas of small rainfall. The area in which the annual precipitation was supposed to be less than five inches has almost disappeared, and that in which the rainfall was put down at less than fifteen inches has been reduced by a quarter of a million of square miles since the Census map of 1880 was made.

General Greely discussed the question of what constitutes an arid region, and said that he does not agree with Maj. J. W. Powell, who placed the minimum amount of precipitation necessary for successful agriculture at twenty inches per annum. He said that millions of bushels of wheat are raised every year where the rainfall is less than twenty inches, and referred to the statistics of Dakota, where more than 2,600,000 bushels were raised in the two counties of Richland and Stutsman in 1885, and 1,500,000 in 1887, with an average rainfall of 13.7 to 15.1 inches.

General Greely also mentioned the interesting fact, that, while the rainfall increases as the rivers which flow directly into the Gulf of Mexico or into the Pacific Ocean are followed up from their mouths, it increases with the distance from the mouths of such as empty into other bodies of water, like the Colorado.

General Greely's charts also prove that much of the rainfall in what has been known as the arid region, and where it was formerly supposed that the precipitation was five inches or less, was not reported. In some of these places the actual rainfall is as much as sixteen inches, and in one it is thirty-seven. This explains why water is found so abundantly in wells in some parts of southern California, where the annual rainfall has been reported as ten, twelve, and thirteen inches: the actual precipitation is twenty-four inches.

General Greely said that he had caused to be placed upon the charts the maximum and the minimum rainfall of the various stations, not expecting that they would indicate any thing, but that the curves were almost as regular as those on the annual maps. He explained that the small average amount of rainfall formerly reported was due in part to the fact that so large a number of stations had been situated along the line of the Pacific Railroad, which, seeking low gradients, had been built through a section of country in which the precipitation was small. He spoke also of the prevalent opinion that the rainfall in the West is increasing, and said that he thinks this opinion to be correct, and closed with the remark that it was not fair to treat that country on the basis of seasonable rains, since the larger portion of the precipitation took place during different months in different sections of the region.

In the brief discussion which followed the address, Prof. G. K. Gilbert said that it was not safe to fix any given amount of rainfall as the minimum necessary for successful agriculture, without qualifications. Very much depends upon the time when the rain falls, and the rapidity with which evaporation takes place. More rain is required in Arizona than in Dakota, and many unsuccessful agricultural experiments have been made in Utah near Camp Douglass, where the annual precipitation is as much as eighteen inches.

Professor Fernow said that he had compared the amount of rainfall during the five months of vegetation, in Philadelphia, Buffalo, Dodge City, and North Platte. It ranges from fifteen to seventeen inches, the largest amount of precipitation being at North Platte. There was no lack of rainfall at the eastern stations, but at North Platte it was impossible to raise a crop. He learned also from Utah that the amount of water needed to irrigate land there was less after two or three years than when it was first turned on.

Prof. C. V. Riley spoke of the frequency and violence of the rainfall as modifying in an important degree its effect.

Folk-Lore of Ireland.

The following is an abstract of a paper read before the Anthropological Society of Washington, Feb. 12, by Jeremiah Curtin: —

For many years I have believed that there was a great stock of myths and folk-lore current among the people in Ireland, as well as an abundance of that class of facts which throw light on the history of the human mind, — facts which would be valuable to the scien-

tific world, and highly prized by this Anthropological Society of Washington. I know that there was a large body of manuscript Gaelic literature of considerable antiquity and of high value, especially that portion of it devoted to mythology, heroic tales, chronicles, and law tracts. I hoped, also, there might still remain in the minds of the people of the remote districts of Ireland many idioms useful in explaining the language of the manuscripts, and many myths and tales that would supplement and strengthen the recorded mythology. I went to Ireland last year, therefore, for the purpose of settling this question by actual investigation, and my first step was to make the acquaintance of the few Gaelic scholars in Ireland, and examine the manuscripts preserved in Dublin.

These manuscripts fill about two thousand volumes, are kept in the Royal Irish Academy and the University of Dublin, and are of various kinds, — histories, chronicles, treatises on law, medicine, astronomy, etc. Among them, and of chief interest to me, were the manuscripts containing the myths and heroic tales of the Gaelic people. These myths and tales, if printed, would fill about ten thousand quarto pages. This is the greatest collection of myths in Europe. It is perfectly unique, both in quality and quantity. Neither in ancient nor modern times had any nation on the mainland of Europe such a collection; and O'Curry very truly said that the single 'Book of Leinster,' if published to the world, would make the reputation of any nation.

The 'Book of Leinster' is but one of many books of its class, though it is the richest of all in contents; and the 'Book of Leinster' is not yet accessible to the world, though it has, with three other volumes, been placed within the reach of a few Gaelic scholars in the form of some *facsimile* copies of the original manuscript, with all the contractions and abbreviations, of which several hundred were used by scribes in the days before printing. Some of the most important of the Gaelic manuscripts of myths and tales have come to us in unique copies, while a great many others of equal value, known by title or extract, have perished. Merely a wreck, a remnant of the old time, has been saved; but it is a wreck so extensive as to excite real wonder and thankfulness.

It is a matter of deep interest, also, to the scientific investigator, to learn that the chronicles of the country, both lay and ecclesiastical, especially the latter, bring to light a great many phases and forms of thought of pre-Christian times of which we have no record elsewhere. There is no church history in western Europe so valuable in this respect as that of the Church in Ireland; for the conversion of the people was voluntary, and the country at that time, and for some centuries later, was free from foreign pressure of every description. All of the ancient beliefs and practices that could posbly be permitted, were permitted. Some of these lived on parallel with the Church, and others were incorporated into it.

After a brief visit in Dublin, where I found assistance, and a most agreeable hospitality from the members of the Royal Irish Academy, the University of Dublin, and the two Gaelic societies, I set out to visit remote places in the west. Without entering into any detailed account, I may state that I visited some of the characteristic and secluded parts of the west coast, and took down personally a large body of myths and stories, some very long, others not so long. This collection of materials is sufficient to fill a couple of twelvemo volumes, and will give some idea of what yet remains in the Celtic mind of Ireland. It is, however, but a small part of that mental treasure still in possession of the people.

One of the largest and finest groups of Gaelic myths is the Ossianic, or myths of Fin MacCumhal and the Fenians of Erin. Fin has his immediate personal attendants. He and they possess fixed and well-determined characters, and their names and exploits are familiar to all who have heard the tales of the Fenians of Erin. There are no stories more popular, and they are interlaced with a great number of other important myths of various descriptions. Every place in the land has witnessed the activity with which Fin and his men struggled with every manner of obstacle, and fought with every kind of foe. Fin and Oisin, according to the stories, were born in a great many places in Ireland. Scotland is as full of their activity and birthplaces. Glencoe, the scene of the celebrated massacre, is a birthplace of Oisin. The account given of how these Fenian or Ossianic stories were preserved is remarkable enough. The authorship of them all is attributed to Oisin, the son of Fin MacCumhal, who told them to St. Patrick. St. Patrick had them carefully written down; but he found them so agreeable and entertaining, as well as so numerous, that he said people would neglect their work and do nothing but listen to these stories, so he destroyed two-thirds of what was told him by Oisin. From the remaining one-third come all the tales of the Fenians now current in Ireland and Scotland. In one of the stories which I collected is a complete account of how Oisin came back from Tir nan Og (the land of youth), after he had been there three hundred years, and told them to St. Patrick.

The time is coming when mythology may become a science, if scholars will work to that end, but mythology is far from being a science yet. There are many theories and loose statements current about mythology, — 'disease of language,' 'sun myths,' 'serpent myths,' etc., — but there is no science in all this. It is fancy, guess-work, efforts of men dealing with insufficient and unsatisfactory materials, collected, in many cases, by incompetent hands or by persons who tamper with materials for the purpose of improving them, or fitting them to some theory.

There is probably no more striking or interesting case of error than that of Max Müller, who has founded a whole theory of mythology on what he calls a 'disease of language.' Now, Max Müller's 'disease of language' is merely an incident in the history of mythology, instead of being, as he makes it, the great central and germinal factor, the parent instead of attendant of mythology. Müller's error is one that could never have been made by a man having proper and sufficient materials at hand from mythologies still intact. The things we need, above all, at present, to advance mythology on the way to becoming a science, are *facts*, and facts in mythology are well-preserved myths. These we need in great number, and in all the variants attainable in each linguistic stock of people.

Among the different branches of the Aryan race in Europe, there is none, as I have already stated, having so extensive and well-preserved a mythology as the people of Ireland. This mythology is to be found in two places, — in Gaelic manuscript, and in the minds of the people of the more secluded parts of the island. Only very small portions of the Gaelic manuscripts have been translated, and still smaller portions published; so that practically this body of material for science is unknown to the world. The work of utilizing it remains to be done. Now, it will be found that the manuscript material can never be properly translated and explained without a knowledge of the words and idioms of the language, as well as the ideas and myths that are in the minds of the Gaelic-speaking people of Ireland.

The Qualities of Fats.

The chemist and microscopist of the Department of Agriculture are engaged in an examination of samples of the lard of commerce, for the purpose of determining its constituents, and also of discovering the best tests for adulteration. Professor Wiley has employed all of the ordinary tests, but gets the best results from one suggested by an Italian chemist, Bechi, in which nitrate of silver is used. Cottonseed-oil, when brought in contact with nitrate of silver, reduces the latter to a metallic state. Professor Wiley has also begun an interesting series of experiments to determine the refraction of different oily substances. The instrument used is Abbé's refractometer, which shows the index of refraction upon a scale upon its side. There is no literature on this subject, and the tables which Professor Wiley proposes to make will be an interesting contribution to the present knowledge of the qualities of fats. X.

Washington, D.C., March 1.

HEALTH MATTERS.

Transmission of Infection by Rags.

THE 'Eighteenth Annual Report of the State Board of Health of Massachusetts' contains a valuable report by Dr. C. F. Withington, who was requested by the board to investigate the question of the transmission of infectious diseases by means of rags. Dr. Withington's report is very full and complete, and is a very fair and unbiassed statement of the facts as we understand them. His conclusions are as follows: —

1. Small-pox has been transmitted through the medium of rags in a certain number of cases, small in proportion to the whole number